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Type of Organization: College or University

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Project Title: Isolating and Bioremediating PCBs in Sediments

Project Category: Contaminated Sediments

Rank by Organization (if applicable): 0

Total Funding Requested ($): 132,156 **Project Duration:** 2 Years

Abstract:

This project will investigate the in situ containment and treatment of PCB-contaminated sediments in rivers and lakes, with particular focus on the Kalamazoo River Area of Concern, one of the larger reservoirs contributing PCBs to the Great Lakes. The use of anchored geotextile layers to minimize bioturbation and suspension and mobilization of PCB-contaminated sediments from hot spots will be tested in the lab and the field. Geotextile fabrics will be selected based on tests of strength, suitable pore openings, and chemical and biological compatibility. The proper geotextile could potentially reduce the introduction of PCBs to the food chain by minimizing burrowing and other bioturbation activities (e.g., sediment mining by carp and other bottom-dwellers) and by stabilizing the sediments for in situ remediation. Using permeable geotextiles anchored by coarse sediments covered with finer sands to isolate contaminated portions of rivers and lakes would continue the natural functional exchange of surface and groundwater while allowing restoration of an uncontaminated food chain. These armored geotextiles would be used to isolate PCBs from the food chain and erosion in highly-contaminated areas where dredging is unacceptable, such as along erodible streambanks and shorelines, near homes and other sensitive areas abutting streambanks and shorelines, and some areas behind drained dams.
Since PCBs are biodegradable only at very low rates, the use of ozone to partially oxidize PCBs for subsequent biodegradation will be investigated as a remediation option. Ozone oxidizes effectively at neutral pH, and can be bubbled through the sediments in hot spots to partially oxidize PCBs to enhance bioremediation rates relative to natural attenuation. Ozone pulsation can be used to alternate oxidizing and reducing conditions which also may enhance remediation. Combining ozone injection with isolation by anchored geotextiles may prove to be a good alternative to dredging.

Geographic Areas Affected by the Project

States:

☐ Illinois	☐ New York	☐ Superior	☐ Erie
☐ Indiana	☐ Pennsylvania	☐ Huron	☐ Ontario
☒ Michigan	☐ Wisconsin	☒ Michigan	☒ All Lakes
☐ Minnesota	☐ Ohio		

Lakes:

Geographic Initiatives:

☐ Greater Chicago ☐ NE Ohio ☐ NW Indiana ☐ SE Michigan ☐ Lake St. Clair

Primary Affected Area of Concern: Kalamazoo River, MI

Other Affected Areas of Concern:

For Habitat Projects Only:

Primary Affected Biodiversity Investment Area:

Other Affected Biodiversity Investment Areas:

Problem Statement:

Problem Statement: The importance of this research to the Great Lakes Basin is clear when one considers that PCBs are present in sediments in many tributaries to the Great Lakes as well as in the lake sediments. Benthic organisms provide the route for entry of PCBs into the food chain, and the geotextile cover proposed could minimize or eliminate this means of entry. Furthermore, many macroorganisms (e.g., carp, and catfish) suspend contaminated sediments during their feeding activities, and the geotextile material would reduce this problem.

Remediation of sediments contaminated with PCBs is a very difficult task. Dredging is the most widely used remedial method. However, it removes aquatic and benthic ecosystems and vegetation, destroys wetlands, and disrupts the natural habitat of fish and
waterfowl. Furthermore, dredging suspends contaminated sediments in streams and lakes, thereby increasing PCB mobility and exposure to aquatic organisms and humans. If dredging is done, dredge spoils must be properly treated and/or disposed. Hence, efforts should be made to treat PCB-contaminated sediments in situ.

Two novel remediation methods are proposed for the in situ treatment of PCB-contaminated sediments in "hot spots" (heavily PCB-contaminated areas) of the Great Lakes Basin: (1) the use of permeable geotextile materials to serve as a "breathing cap" for PCB-laden sediment; and (2) the use of partial chemical oxidation of PCBs with ozone to enhance their biodegradability. Both methods could be used separately or in combination. See below for more details.

Geotextile Barrier (Drs. Duane Hampton, Geosciences, and Steven Kohler, Biology): The anchored geotextile barrier is an in situ technology that would serve two purposes; (1) to serve as a barrier to biointrusion by burrowing organisms; and (2) to keep heavily contaminated sediments from being suspended during normal runoff and flooding events. Since organisms that burrow into the benthos are at the bottom of the food chain, the geotextile blanket would impose a barrier on the introduction of PCBs into the food chain. Reducing the mobility of PCB-contaminated sediments in hot spots is crucial to remediation efforts and to drainage basin management. Permeable geotextiles are man-made materials that have been used extensively for stabilizing stream banks and for landfill leak detection layers. Geotextiles can allow the passage of gases (e.g., oxygen) and water, but not sediments. The geotextile material can be anchored by covering it with a thin layer of sand and/or gravel (depending on the prevailing water velocity). Appropriate emergent vegetation would be established over geotextile barriers to return these areas to normal biological function and to further stablize the sediments against erosion and resuspension.

Ozonation (Dr. Daniel Cassidy, Geosciences): The partial oxidation of PCBs using ozone followed by biodegradation shows considerable promise as a remediation technique. PCBs are common and persistent bioaccumulative contaminants in the Great Lakes Basin. PCBs biodegrade, but rates are extremely slow. One way to enhance PCB biodegradation is to

partially oxidize the molecules with ozone. Combined physical /chemical pre-treatment followed by biodegradation has become an increasingly popular method to biodegrade recalcitrant organics in waste streams, soils and sediments. While many chemical oxidation methods exist, ozone is more attractive than permanganate and peroxides because it works well at a neutral pH, which is a requirement for use in aquatic environments. Ozone produces hydroxyl free radicals, which are known to oxidize PCBs. The oxidation products are more soluble and more biodegradable than PCBs themselves. The purpose is not to completely oxidize PCBs, but only to partially oxidize them so that the products can be biodegraded. Dosing requirements will be determined in lab experiments using contaminated stream sediments. We will also test the sensitivity of biodegradation rates to the presence of PCB degradation-inducing compounds, such as biphenyl and p-cymene. We will also test the effects of pulsing ozone delivery, causing alternating oxidizing and reducing conditions. If the biodegradation rate can be increased using some of these ideas, we can draw upon established technology (e.g., ozone sparging) for sediment remediation.

Proposed Work Outcome:

Geotextiles will first be tested in the laboratory to determine their strength, permeability, and chemical and biological compatibility. Once appropriate materials are selected, test patches will be installed in a lake or stream to allow field testing of the effectiveness of the materials for containing sediments and for reducing bioturbation and sediment suspension by fish and other bottom dwellers.

The effect of ozone on biomineralization of PCBs will be tested in laboratory feasibility studies. These tests will determine dose requirements, whether ozonation enhances PCB mineralization, and whether enhancing compounds are useful. Initial tests will be conducted in reactors without soil. Tests with soil will then be conducted to determine the effect of soil on ozone dosage, and to identify potential mineral and organic ozone scavengers.

The outcome of the proposed work will be the anchored geotextile biointrusion barrier tested in the field and the ozonation/bioremediation technology tested in the laboratory. Both technologies have ample application for use in sediments with heavy PCB contamination in the Great Lakes Drainage Basin. Environmental results from the proposed research would include a reduced presence of PCBs in the food chain, reduced transport of PCB-contaminated sediments from tributaries into the Great Lakes, and a potentially cost-effective means of accomplishing remediation of PCBs.

Project Milestones:	**Dates:**
Project Start	09/2000
Develop Quality Assurance Project Plan	10/2000
Lab tests to find suitable geotextiles	06/2001
Lab study of ozone for pre-treating PCBs	06/2001
Identify benthos in PCB-laden sediments	07/2001
Install geotextile patches, ozone pipes	08/2001
Sample PCBs and benthos under patches	07/2002
Project End/ Draft Report	08/2002

☒ Project Addresses Environmental Justice

If So, Description of How:

An angler survey has revealed that many people who fish in the Kalamazoo River were unaware of the advisory not to eat the fish they take. The heads of the Kalamazoo and Allegan County Health Depts. believe that a disproportionate number of those who refused to participate in the survey (roughly half of those approached) and who regularly fish the river are poor and African-American or from the Hispanic migrant worker community around Fennville. These anglers are presumed to use the fish they take to help feed their families. While the PRP group, the MDEQ and the EPA work toward remediating the river, risk to human health as well as to the environment continues to fall heavily upon poor and minority populations. We sincerely believe that the proposed remedial technologies to be researched have potential to substantially reduce PCB concentrations in the river, in the biota and ultimately in humans and in Lake Michigan. We believe that these technologies also could accelerate the cleanup because they are easier to implement than dredging, which introduces contentious and time-consuming issues of siting landfills for dredge spoils. Unfortunately, many of the disposal sites for dredge spoils will probably be located near minority populations for economic reasons.

☐ Project Addresses Education/Outreach

If So, Description of How:

Project Budget:

	Federal Share Requested ($)	Applicant's Share ($)
Personnel:	61,982	8,264
Fringe:	5,666	1,736
Travel:	7,900	0
Equipment:	14,000	0
Supplies:	10,000	0
Contracts:	2,300	0
Construction:	0	0
Other:	0	0
Total Direct Costs:	101,848	10,000
Indirect Costs:	30,308	3,450
Total:	132,156	13,450
Projected Income:	0	0

Funding by Other Organizations (Names, Amounts, Description of Commitments):

Western Michigan University, $13,450, Reassigned time for Drs. Cassidy and Hampton, years 1 and 2

Western Michigan University Environmental Institute, Dr. Chuck Ide, has offered a match for year 2 GLNPO funding, dollar for dollar, if the Institute is awarded the $3 million grant from the EPA that it is seeking for that time period. That grant would be to support research on the Kalamazoo River AOC. An EPA grant for $1 million was awarded to the Institute for this coming year for research and outreach on the Kalamazoo River AOC. This $1 million grant has to be matched dollar for dollar by non-federal funding sources, so it is not available as a match for our proposal to the EPA.

Description of Collaboration/Community Based Support:

To test our proposed anchored geotextile barriers and ozone injection, we need access to a field research site preferably in a contaminated stretch of the Kalamazoo River AOC. While no promises have been made for site access, we have a preliminary indication of cooperation from the paper companies which constitute the Potentially Responsible Party (PRP) group for the Kalamazoo River AOC. Mark Brown, Vice-President of Blasland, Bouck and Lee, and representative of the PRP group, said that the anchored geotextile biointrusion and erosion barrier in our proposal would have to be a component of the remedial plan for this Superfund site. He said this because the greatest risk to human health and the environment at this AOC is erosion of fine sediments contaminated with PCBs that were deposited behind dams that subsequently were drained and removed. Hence these fine sediments are now being cut into by the river and are the major source, in his opinion, of the PCBs going into Lake Michigan. The Kalamazoo River AOC is one of the major sources of PCBs in Lake Michigan. The geotextile erosion barrier would cut off this source of PCBs wherever it is used, which would most likely be along the streambank where erosion is most severe.
Here is an idea which would be acceptable to the PRPs which also has scientific and engineering merit. Funding this project would foster collaboration between the EPA, the PRP group, Western Michigan University (WMU) and hopefully Michigan Dept. of Envir. Quality (MDEQ) in the search to find acceptable remedial technologies for the Kalamazoo River. This research area is usually the domain of the U.S. Army Corps of Engineers. We would be happy to work with them in furthering this technology. Indeed, we anticipate that such ties will be initiated during this project. The Corps is funding another project in the Geosciences Dept. at WMU studying failure of the bluff along Lake Michigan, and we look forward to augmenting that collaboration.